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 **UltraVis**  
SciDAC Institute for Ultrascale Visualization

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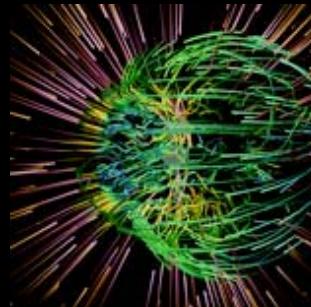
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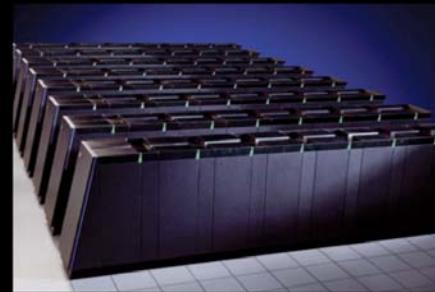


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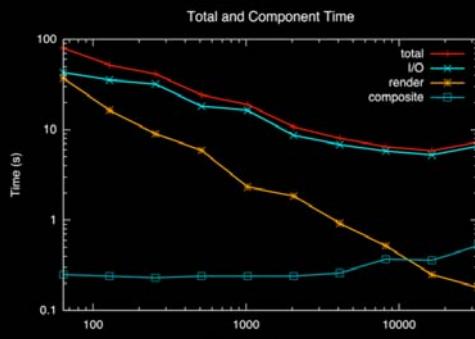
# Autostereoscopic Display of Large-Scale Scientific Visualization



Scientific data



Supercomputer visualizations



Scalable algorithms



Immersive environments

Rob Ross - ANL

Hongfeng Yu - SNL California

Kwan-Liu Ma – UCD

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Javier Girado - Qualcomm

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Mathematics and Computer Science Division

# Ever-Increasing Scale of Data and Visualization

Must manage both performance and perception

## Size and complexity of selected computations

Dataset	Problem size (billion elements)	# variables	Year	PI
Lifted H2 air	0.9	14	2008	Grout
Lifted C2 H4 air	1.3	27	2008	Grout
Supernova	1.3	5	2008	Blondin
Turbulence	8.0		2005	Yeung

Often time-varying scalar and vector data

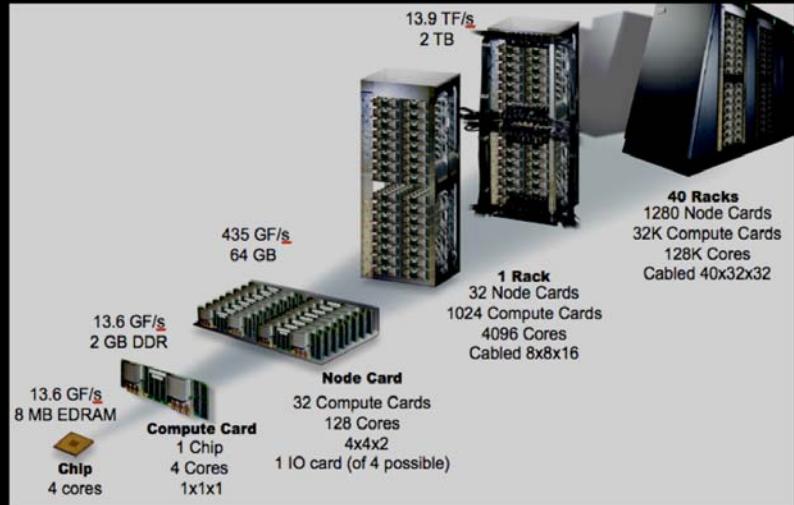
## Data size of selected 2008 INCITE awards

Domain	Data size (TB)	PI
Fusion	54.0	Klasky
Materials	100.0	Wolverton
Astrophysics	300.0	Lamb
Climate	345.0	Washington

Total data written as of June 2008

# Apply Leadership Computing Resources

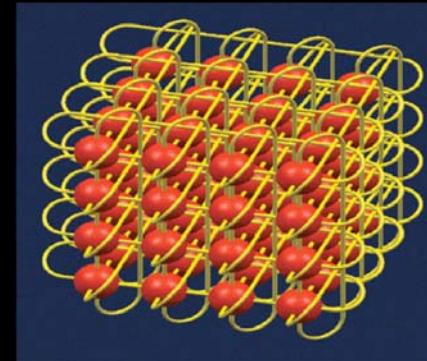
## Computation, communication, and storage



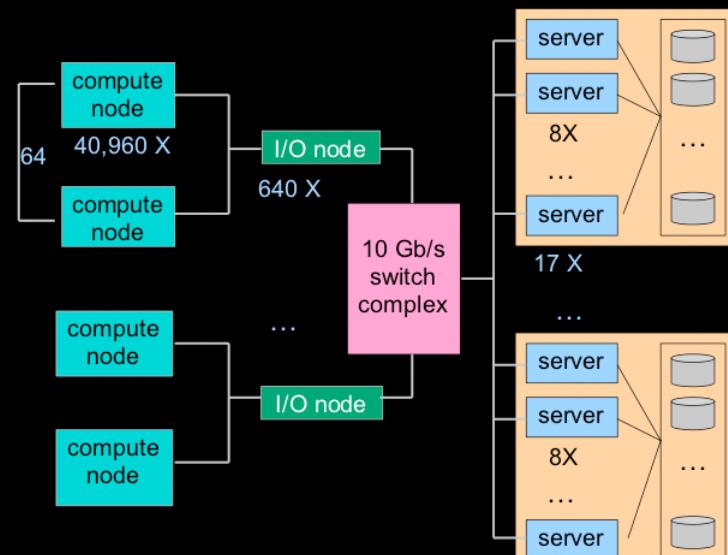
Scalable compute architecture



Argonne Leadership Computing Facility



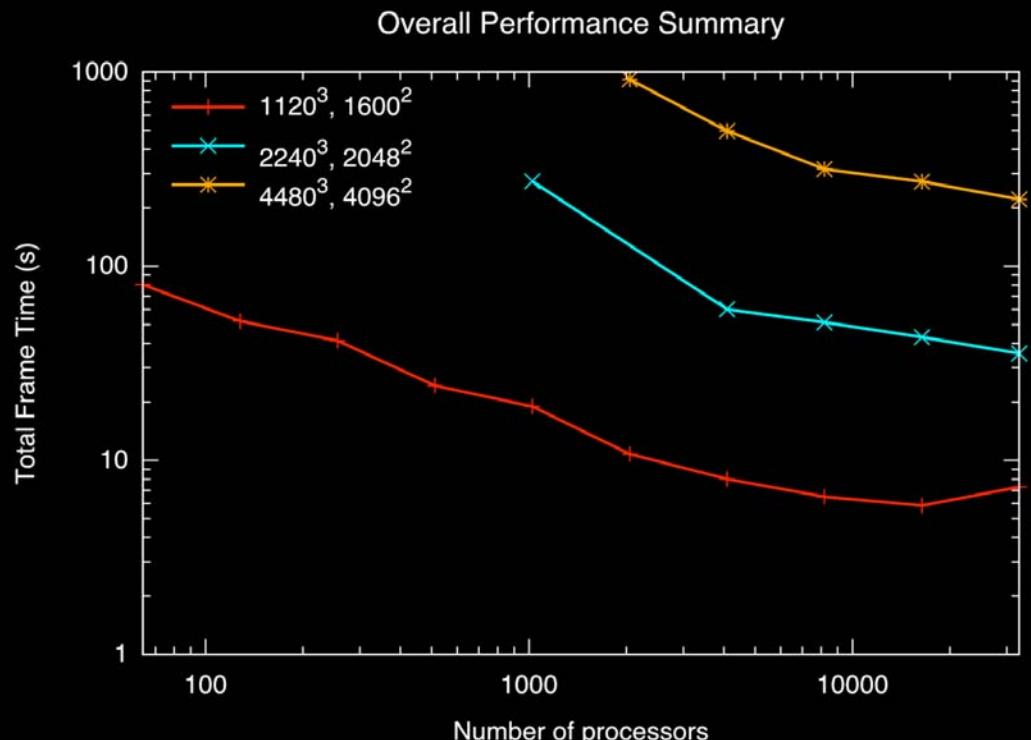
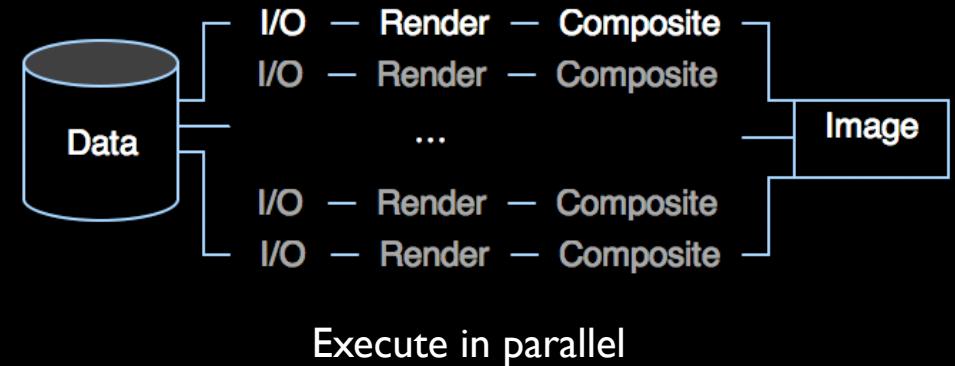
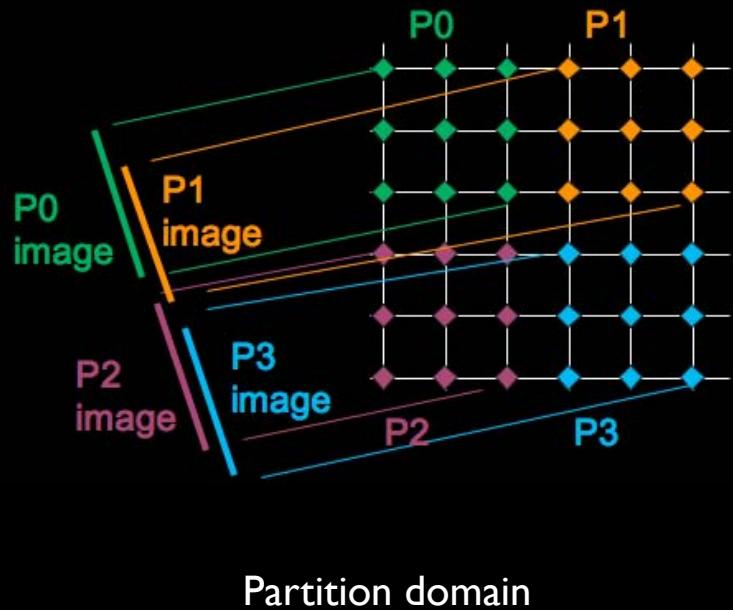
3D torus interconnect



Parallel storage

# Develop Scalable Algorithms

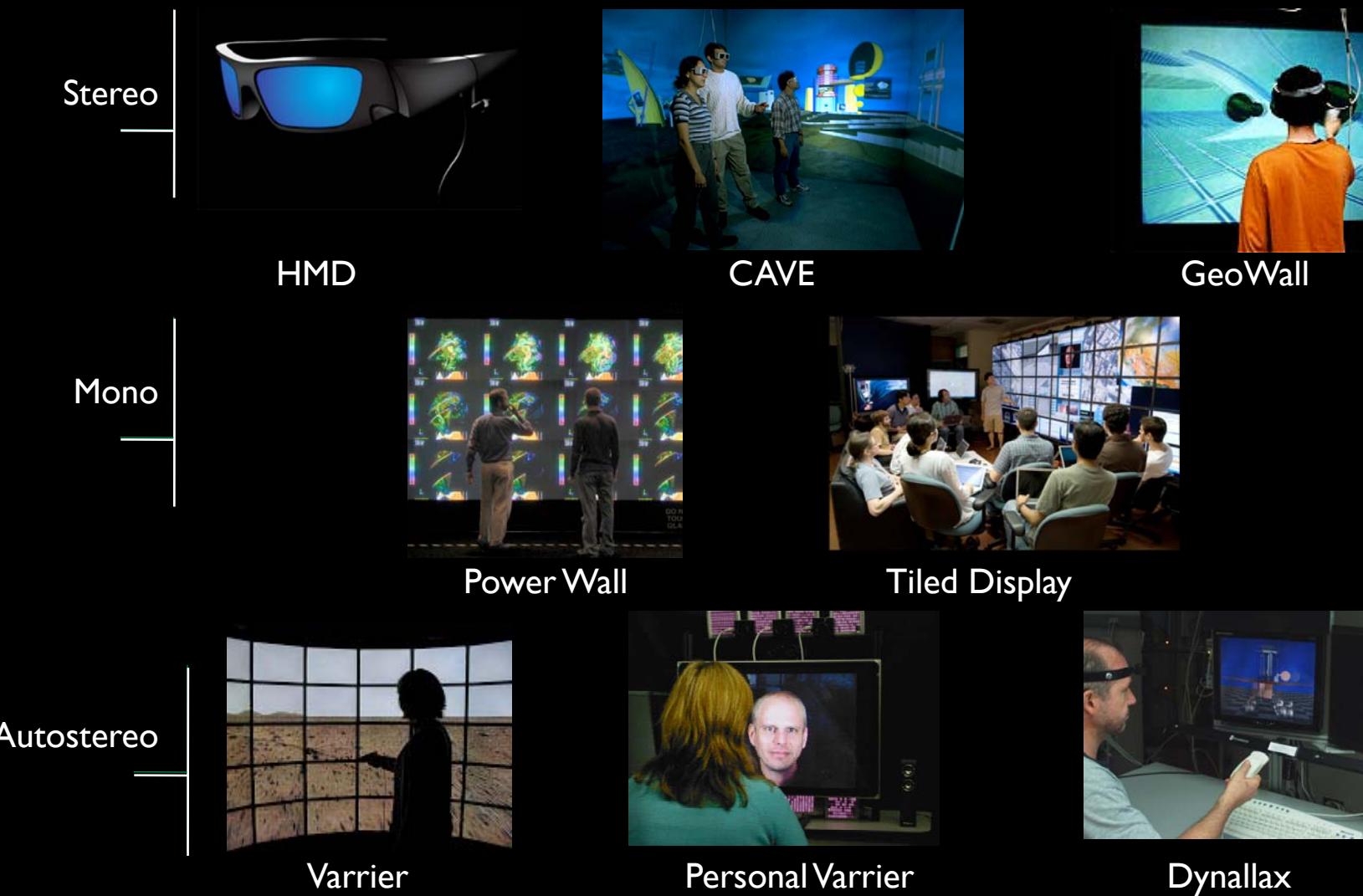
## Parallelism in visualization



Analyze performance

# Interact Through Virtual Environments

3D immersion: be the data



# Why Bother?

## Specifically, why stereo and autostereo?

### Stereo: Benefits over mono

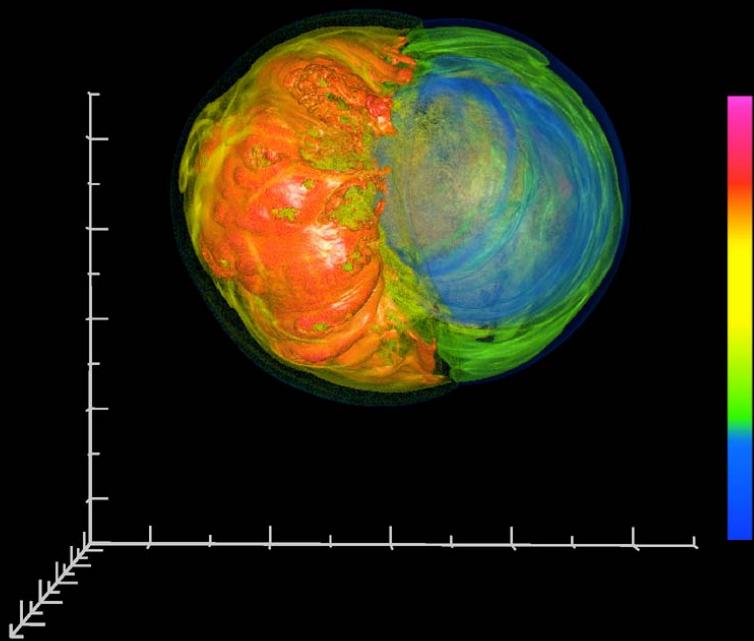
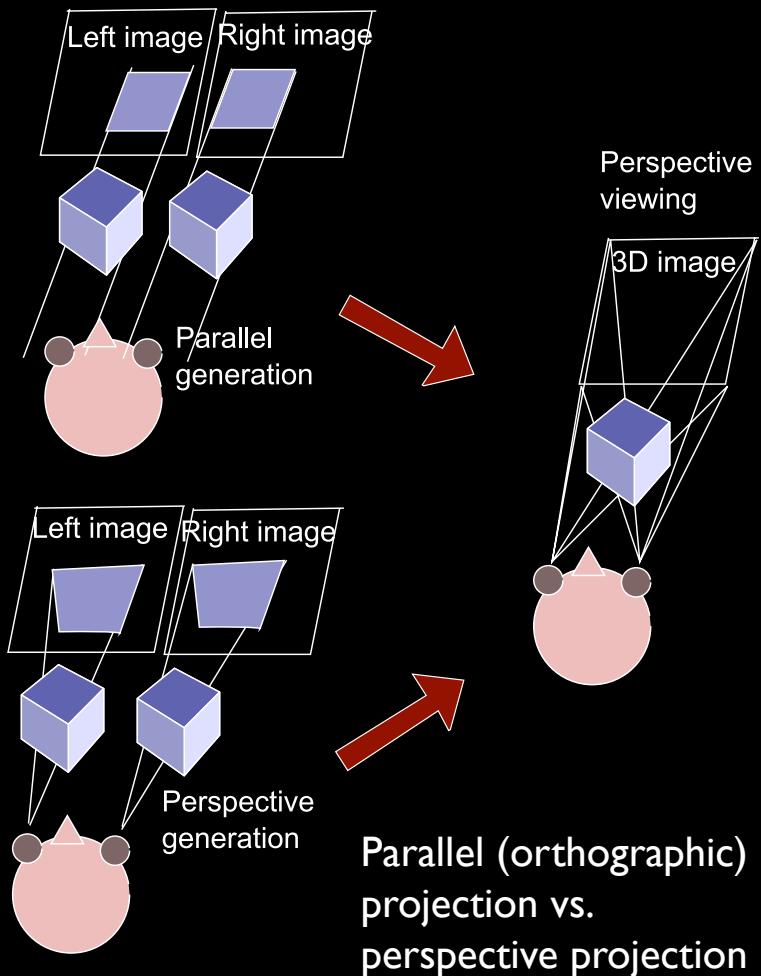
- Data size and complexity
- Powerful depth cue
- Absolute depth measurement
- Disambiguates nearby data
- Increased visual bandwidth
- Increase data density
- Avoid clutter
- → Improve understanding

### Autostereo: Benefits of stereo, plus

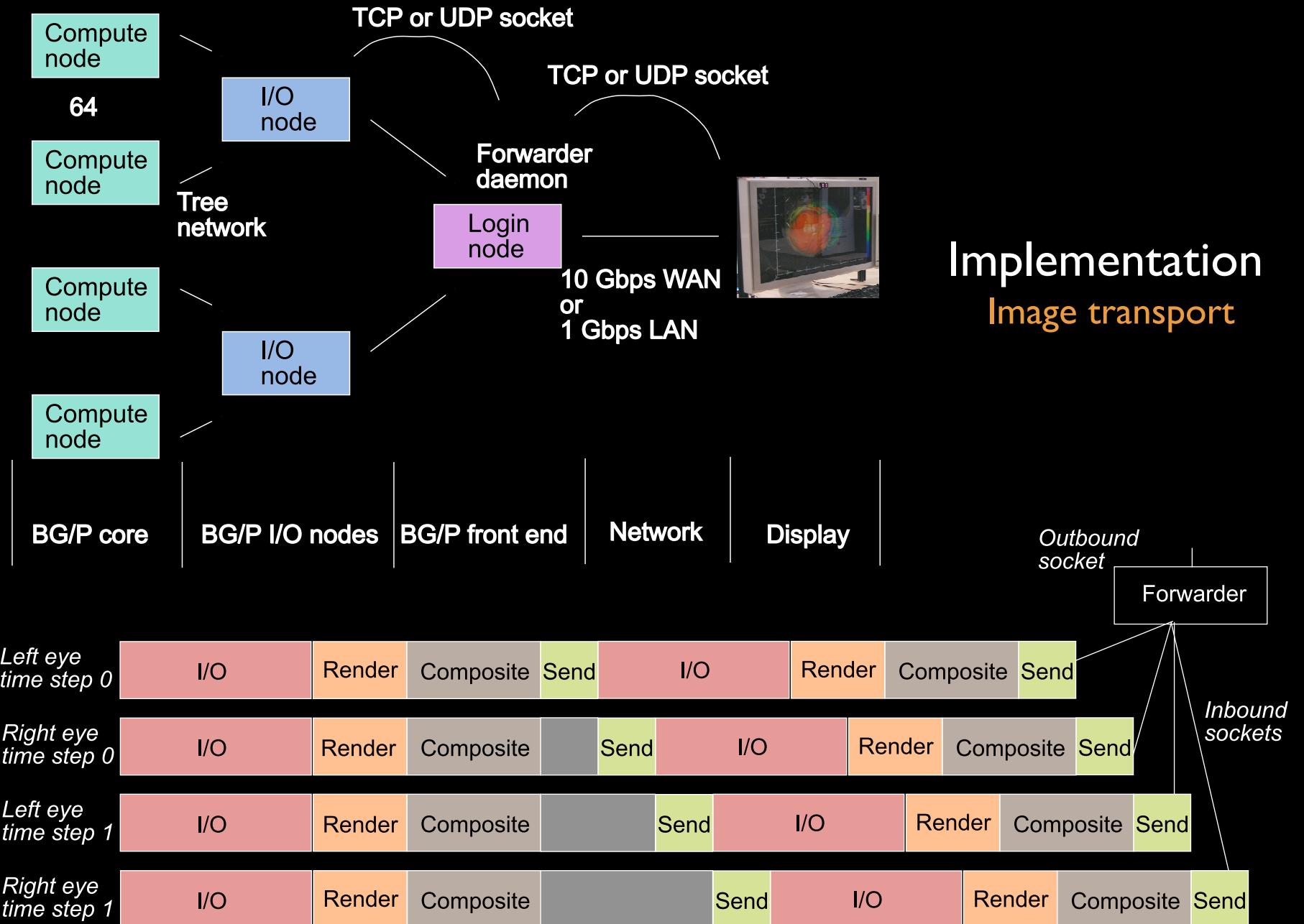
- Increase level of engagement
- More direct, human-like interface
- Less gear
- Easier to multiplex into other tasks
- → Improve accessibility

# Implementation

## Projection and rendering methods



Combine remote and local information: grid and colormap rendered locally while supernova rendered remotely



# Interaction

## Head tracking, navigation, work environments

Scientist workstation



Direct interaction



Common / demo space

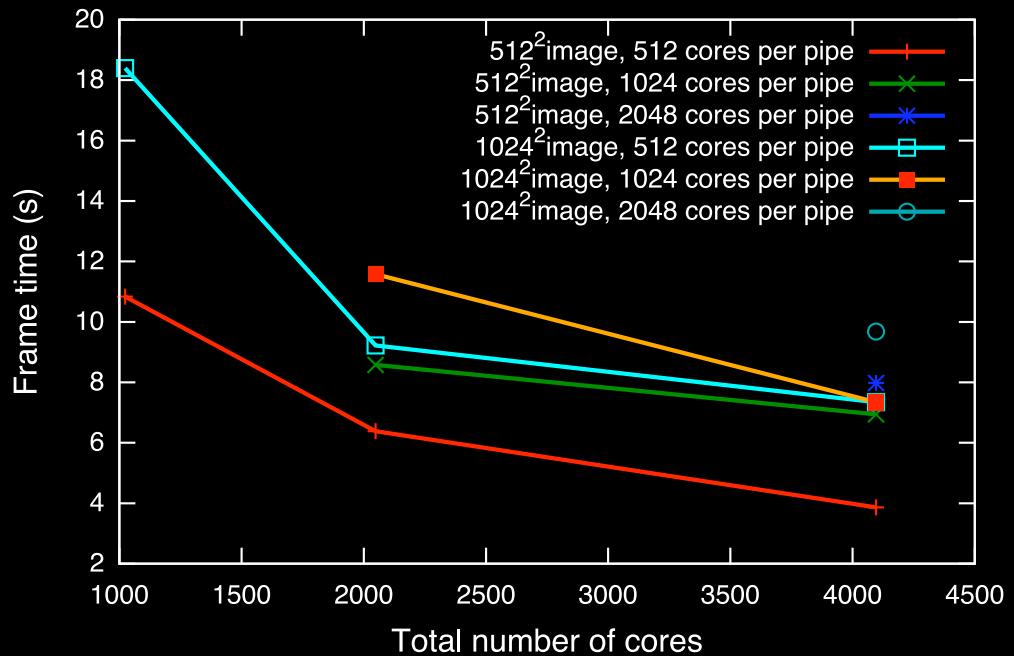


Tetherless face tracking



SC08 show floor

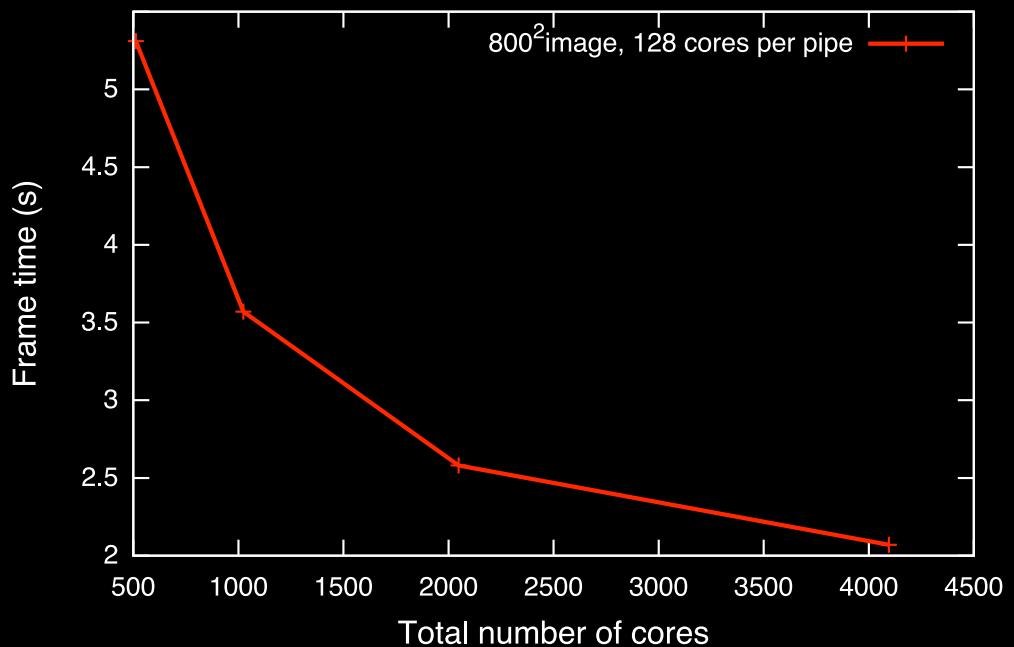
## Stereo Pipelines, $864^3$ data



## Performance

Pipelines hide I/O latency,  
making overall performance  
scalable.

## Stereo Performance, $864^3$ data



Cores	End-End Time (s)	Efficiency (%)
512	5.31	100
1024	3.57	74
2048	2.58	51
4096	2.07	33

# Lessons Learned and the road ahead

## Successes

- end-end modest scale functionality
- 3 hr demo: volume rendered 3600 time steps, 8.6 terabytes of data
- supercomputer back end connected to autostereo front end
- client-side interaction

## Challenges, to do

- server side interaction
- improve performance
- visualization hierarchy
- quantify perception

## Initial reactions

- Fabulous! (Tony Mezzacappa)
- Less than positive responses as well



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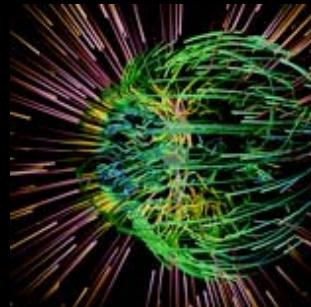
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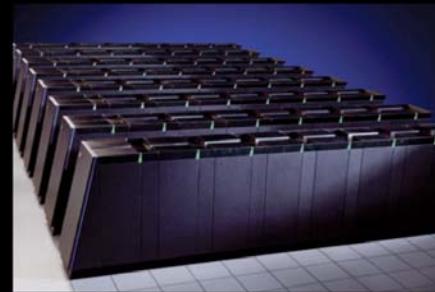


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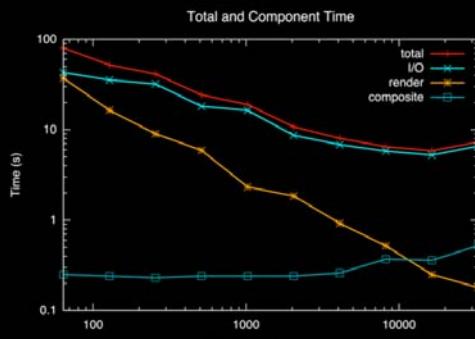
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